ESRF	**Experiment title:** Dynamic fracture in implanted silicon wafers	**Experiment number**: MA-4338
Beamline: ID19	**Date of experiment**: from: 24/09/18 to:25/09/2018	**Date of report**: 01/03/2022
Shifts: 6	**Local contact(s)**:Margie Olbinado/Alexander Rack	*Received at ESRF:*

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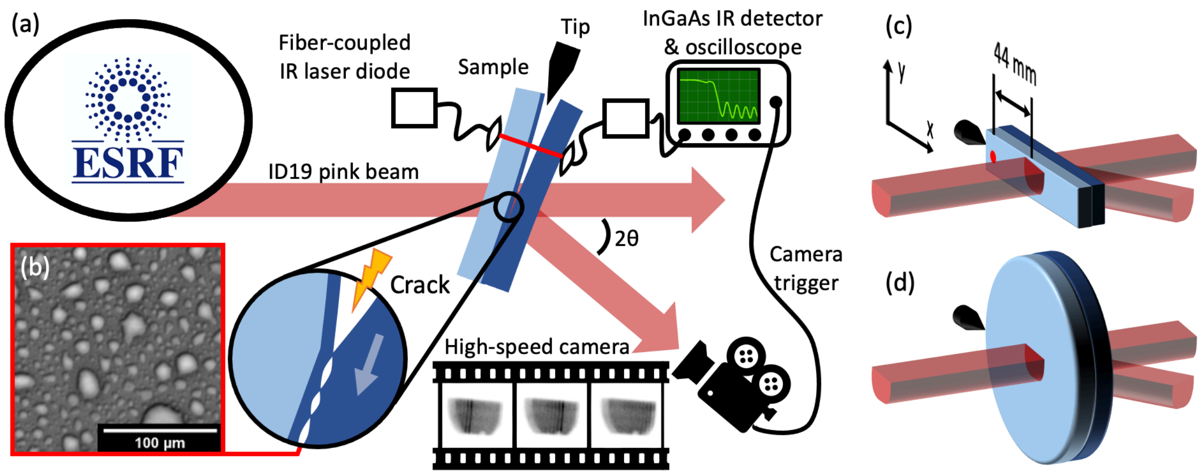
Report:

The design and the results of the experiment and its details will be the subject of a publication which is ready for submission[1]. Hence this report is an extended abstract of this publication.

The idea of the experiment was to use Bragg scattering to visualize a crack propagating in a crystal. Due to the angular displacement of the crystal around the crack and in the crack wake, imaging the scattered beam(s) allows tracking of the crack front progression. The velocity of the crack (typically 2km/s) requires short illumination (provided by the ESRF ring electron bunches) and fast acquisition. Triggering has been performed by optical means.

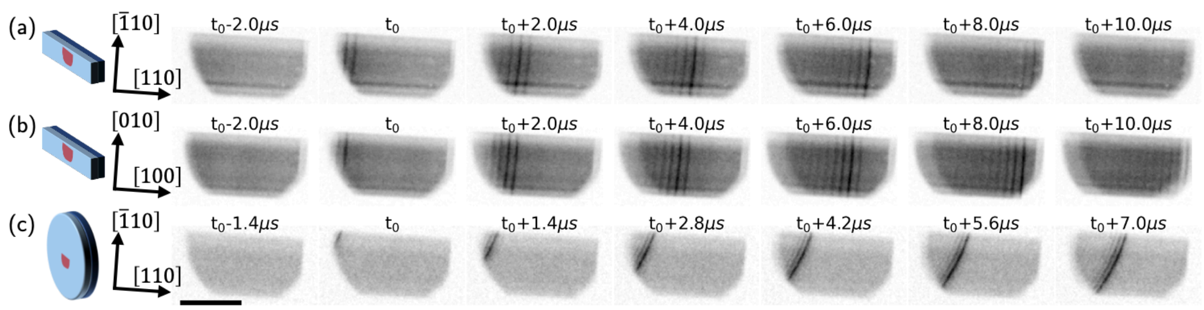
The experimental setup is shown here

[1] *[1] A.Petit et al, Dynamic brittle fracture imaging by synchrotron X-ray diffraction, to be submitted to Int. J. of Cryst. (2022)*



The typical size of the beam on sample at the 120m distance from the source is typically 25x15mm which allows imaging a reasonable surface area. The crack front is visualized by an intensity increase due to the strong stress field around the crack.

Examples of image sequences are shown below *for different sample shapes*



These images show clearly the footprint of the crack front moving across the (pseudo-rectangular) illuminated field. The shape and the motion of the crack front are consistent with a regular propagation of the crack. Series of footprints can be visualized due to the afterglow time delay of the camera scintillator. This allows 'stroboscopic" video sequence image tratment.

In addition to crack front imaging, these experiments give also informations about the movements of the two separated crystals in the "wake" of the crack front, looking for example to the edges of each scattered beam (see e.g. sample b above). This has been modelled in a recent paper [2] and X-ray results are fully consistent with the analysis provided.

In summary, this experiment is, to our knowledge, a first-time experiment, combining the few ps time resolution of synchrotron light bunches, with high speed cameras. The results show a regular progression of the crack front, which rules out (at least in this geometry) e.g. theories predicting instabilities of velocity due e.g. to emission of secondary cracks (crack front waves).

[2] P. Ronseaux et al, *Experimental study of post-crack vibrations in dynamic fracture J. Appl. Phys. 129, 185103 (2021); https://doi.org/10.1063/5.0047626*